Things That Talk

Object Lessons from Art and Science

edited by Lorraine Daston

ZONE BOOKS · NEW YORK

2004

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ZONE BOOKS
1226 Prospect Avenue
Brooklyn, New York 11218

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Printed in the United States of America.

Distributed by The MIT Press,
Cambridge, Massachusetts, and London, England

Library of Congress Cataloging-in-Publication Data

Things that talk : object lessons from art and science
/ Lorraine Daston, editor.
p. cm.
Includes bibliographical references and index.
ISBN 1-890951-43-9 (cloth)
1. Art and science. 2. Semiotics and art.
3. Object (Aesthetics). 4. Object (Philosophy).
I. Daston, Lorraine.

N72.S3T55 2004
701'.1—dc21 20033053811

Contents

Preface *Things That Talk* 7
Lorraine Daston

Introduction *Speechless* 9
Lorraine Daston

Chapter I *Bosch's Equipment* 27
Joseph Leo Koerner

Chapter II *The Freestanding Column in Eighteenth-Century Religious Architecture* 67
Antoine Picon

Chapter III *Staging an Empire* 101
M. Norton Wise and Elaine M. Wise

Chapter IV *A Science Whose Business Is Bursting: Soap Bubbles as Commodities in Classical Physics* 147
Simon Schaffer

CHAPTER FIVE

Res Ipsa Loquitur

Joel Snyder

Introduction

A Russian archaeologist friend once took the time to describe to me the relations between the discipline of archaeology in the USSR and the Soviet state security apparatus in the difficult days of the late 1940s: a large team of archaeologists in Siberia discovered the foundation of an ancient church dating back nearly a thousand years to the origins of Christianity in Siberia. In a compartment at the deepest level of the foundation, they uncovered a tomb, replete with bones that were identified via a partially effaced inscription as those of a bishop. The archaeologists immediately divided into two groups, one claiming the bones were those of the region's first bishop, Saint Cyril the Lame, and the other opting for the second bishop, Saint Demetrius the Martyr. The debate grew heated, and finally the leader of the expedition decided to pack the bones carefully and ship them to the best forensic laboratory in the Soviet Union, the NKVD Laboratories in Moscow. The large crate was sent to Moscow with a note: "Comrades, can you determine if the enclosed are the bones of St. Cyril the Lame, or St. Dmitri the Martyr?" Nearly six months later, the chief of the expedition received a large envelope from NKVD headquarters. When he opened it, he found a letter cushioned by a large amount of white powder. The letter was direct and brief: "Comrade, we have finally made the identification you requested last summer; it is definitely Cyril." Delighted by the response but mystified by the lack of details concerning the method of identification, the director sent a brief inquiring telegram to the NKVD: "How do you know?" A responding telegram from the laboratory arrived a week later with a two-word response: "He confessed."

Granting a voice to inanimate things can strike us as torturing, perhaps even violating language. Some philosophers — I am thinking in particular of Saint Thomas Aquinas — locate the distinction between things and persons in what they take to be the unique human capacity to use language. Beings are human, according to Saint Thomas, if and only if they have the capacity to talk (and not merely to make sounds, like those made by macaques or cardinals). Every other kind of thing is not a human being. This neat division between persons and things is conditioned on a conception of language as more than a collection of sounds made in accordance with rules, although systems of syntax, semantics, and pragmatics are obviously at the heart of language.

In the past 125 years, inventors have produced a variety of machines that seem to talk — Edison's phonograph, the Dictaphone, tape recorders, the "talking pictures" — but these don't really talk; they play back what once were called "transcriptions" of human speech. These may be things that make intelligible human sounds, but they are not talking machines. It would be misleading to think of them as capable of repeating what we say.

At the outset of part 1 of *Philosophical Investigations,* Ludwig Wittgenstein asks us to "conceive . . . a complete primitive language game" consisting of only four words — "block," "pillar," "slab," "beam" — played by a builder and his assistant. We are to

imagine that in the course of their work, the builder calls out a word and the assistant brings the designated material. One of Wittgenstein's goals in this section is to show us that if we take the exercise seriously, we cannot, in fact, conceive of human beings whose entire language is limited in this way; the game he asks us to imagine can only be played by beings who already possess a language. We are supposed to wonder how, for example, the players could have learned only these four words and no others. From whom could they have learned them? How does language acquisition work, and what are the conditions of playing a language game? There have been times when perfectly pragmatic, not particularly poetic people have granted things the ability to talk, and not just a few words, but language as we use it. At such times, they are acting under compulsion; something about the way in which they think about some subject forces them to concede to things the capacity to talk. There was a time in the United States when lawyers inclined their ears and heard photographs talk. I will return later to the issue of photographs that talk.

Mechanical Copies of Nature

Published accounts of the invention of the daguerreotype — a process for making pictures described by the authors of the articles as wonderful, magical drawings or engravings — began to appear in popular journals in France, England, and the United States in February 1839, a few months before specimen daguerreotypes were finally made available for unrestricted display in Paris and the first details of the procedure were made public. These reports, based primarily on hearsay, described difficult-to-imagine marvels, "incredible" pictures that were hidden from the view of the writers. Despite the absence of direct evidence, the authors described things they had not seen and simultaneously attempted to locate daguerreotypy within the customary vocabulary and categorical schemes routinely used by picture makers and critics of visual art.

In one of the earliest reports, an unnamed contributor to the *Spectator* published an article "gleaned principally from fragments of the report of M. Arago [to the French Academy of Sciences], quoted in the communications of the foreign correspondents of the *Athenaeum* and the *Literary Gazette,* and partly from private information":

> An invention has recently been made public in Paris that seems more like some marvel of a fairy tale or delusion of necromancy than a practical reality: it amounts to nothing less than making light produce permanent pictures, and engrave them at the same time, in the course of a few minutes. The thing seems incredible, and, but for indisputable evidence, we should not at first hearing believe it; it is, however, a fact: the process and its results have been witnessed by M. Arago, who reported upon its merits to the Academy of Science.[1]

What interests me particularly about this article is the way in which the correspondent, who refers to the daguerreotype as "a discovery the most remarkable in the history of art," begins by figuring the process as a means of enabling nature to "reflect and engrave her own face though but as 'in a glass, darkly,' and engraving it too, that we may have copies of it!" and then moves, I almost want to say "naturally," to characterize daguerreotypy as "mechanical":[2]

> This looks like superseding Art altogether; for what painter can hope to contend with Nature in accuracy or rapidity of production? But Nature has only become the handmaid to Art, not her mistress. Painters need not despair; their Labors will be as much in request as ever, but in a higher field: the finer qualities of taste and invention will be called into action more powerfully; and the mechanical

> process will be only abridged and rendered more perfect. What chemistry is to manufactures and the useful arts, this discovery will be to the fine art; improving and facilitating the production, and lessening the labor of the producer; not superseding his skill, but assisting and stimulating it.[3]

The placement of daguerreotypy (and, a bit later, photography as a whole) within the realm of the mechanical has dominated discussions of photography from the beginning. What has been overlooked, however, is that the term "mechanical" had long been entrenched in the curricula of art academies and schools, was constantly referenced in artists' practice itself, and was standard fare in the discourse of art criticism. What interests me particularly, however, is the way in which the specific qualities identified by the term "mechanical" – those features that the word was meant to isolate and underscore – shift over time, for these alterations of meaning affect, in different ways, the sense of the general claim that photography is a mechanical method of depiction. I have no interest in correcting the historical record or in denying (or affirming, for that matter) the mechanical character of photography. What I would like to achieve is some clarity about the range of possible meanings of "mechanical" at various moments in the nineteenth century. A generalized, one-size-fits-all account of "mechanical" will only block an understanding of why, for example, the introduction of photographs as evidence was often challenged (at times successfully) in American courts of the 1860s and 1870s. Each side in these contests insisted on the mechanical character of photography but, arguing from this premise, reached opposing conclusions. I will return to this problem in the next section.

A significant portion of the *Spectator* article is aimed at "calming the apprehensions of the more humble class of artists," fears rooted in persistent rumors emanating from Paris that the daguerreotype would drive them out of business. But in addressing this pressing concern, the author adopts terms from the vocabulary of a centuries-long discussion among painters and critics regarding the distinction between copying and inventing and from a more recent debate about the aesthetic implications of using aids to drawing — simple items like the Claude glass (a small slightly convex, darkly tinted mirror), plane mirrors, prisms, and more complex aids such as the recently invented diagraph or the ancient camera obscura. The term "mechanical" is used in the journal report in a way that echoes its use in then contemporary art practice, pedagogy, and criticism: it functions as a foil for artistic invention. When the author states, "the mechanical process will be only abridged and rendered more perfect," he is referring not to the perfection of daguerreotypes but to an improvement of the manual skills of those artists who will study and copy them. "Mechanical dexterity" — skill of hand — is a necessary (but by itself an insufficient) condition for the production of art. Daguerreotypes will provide artists with model copies that can in turn be copied by hand (thus compressing the labor involved in copying directly from nature), freeing them to concentrate on invention (or allowing them to become better copyists). The author of the *Spectator* report is not breaking new ground in underscoring the importance and yet devaluing the mechanical aspect of painting; he follows an old distinction, popularized by Sir Joshua Reynolds (one that became canonical in the United Kingdom) in his *Discourses on Art*, between the mechanical and the intellectual/imaginative components of painting. This is a use of the term "mechanical" that, though now nearly obsolete, was in widespread use (and not only in the context of painting and drawing) well into the late nineteenth century. In this sense, the term "mechanical" is synonymous with "manual" (or, at times, "corporeal"). The mechanical

trades were the manual trades, and a mechanic was not someone who worked on machines but someone who earned his living by the skill of his hands or simply through bodily labor.

Reynolds's *Discourses on Art* can usefully be understood as a series of lectures aimed at distinguishing the mechanical element of painting from its peculiarly artistic component. In the hands of an ungifted painter, the mechanisms of painting amount to little more than the ability to repeat the rules of correct drawing through the disciplining of the hand and the education of the eye, each achieved by the endless, monotonous, step-and-repeat operations involved in the copying of plaster casts, engravings, paintings, and human models.[4] The results of mechanical drawing are pictures precisely representing the details of their subjects in all their particularity.

In discourse 1, Reynolds criticizes student artists who concentrate on developing "a lively, and what is called a masterly, handling of the chalk or pencil. . . . Whilst boys, they are arrived at their utmost perfection; they have taken the shadow for the substance; and make the mechanical felicity, the chief excellence of the art, which is only an ornament."[5] The concluding discourse opens with the following lines:

> It has been my uniform endeavor, since I first addressed you from this place, to impress you strongly with one ruling idea. I wished you to be persuaded, that success in your art depends almost entirely on your own industry; but the industry which I principally recommended, is not the industry of the HANDS, but of the MIND. As our art is not a divine gift, so neither is it a mechanical trade.[6]

As Reynolds has it, mechanical work in drawing and painting is always the activity of copying, whether the subject copied is a painting by an acknowledged master, a figure, or even a landscape.[7]

A copy is an exact and precise representation of its model; the copy contains no new ideas; it is governed by the rules of mechanical work embodied in the hands and eyes of its maker. "Mechanical," then, applies both to the qualities of a picture (its precise delineation of the subject in all its particularity) and to the skills of hand that produced it.

To call daguerreotypes mechanical is to say they are correct, particular, and precise in their details; it is to qualify them as copies of some thing or group of things. The machinery of photographic production is in no way central to this use of "mechanical."[8]

For the author of the *Spectator* report, the differences between mechanical copies executed by hand and those done by means of the daguerreotype process are, nonetheless, remarkable. Daguerreotypes of stationary objects under proper conditions of light and in the appropriate weather can provide "accuracy of form and perspective, a minuteness of detail, and a force and breadth of light and shade, that artists may imitate but cannot equal." The superiority of daguerreotypes to copying by hand – "the precision and accuracy of their effects – is explained by the author's unsupported and, to me, somewhat mysterious claim that no "painter can hope to contend with Nature in accuracy" or in the speed of production.[9]

It might seem, then, that the excellence of the daguerreotype, in respect to accuracy and precision of detail, is a direct result of the chemical, "self-operating" character of the process, but the author allows that these pictures are not always mechanical copies – things or persons in motion may be "imperfectly represented" – even though the process is always self-operating:

> As it is the continued stream of light that acts upon the metal, fixed objects only can be delineated: "the foliage of trees," again to quote M. Arago, "from its always being more or less agitated by the air, is

> often but imperfectly represented. In one of the views, a horse is faithfully portrayed except the head, which the animal had never ceased moving: in another, decrotteur (shoe-black), all but the arms which were never still."[10]

It is stunning that the written reports of the first exhibitions of daguerreotypes, in July 1839, and, a month later, of the official announcement of the details of the process did not significantly differ from earlier articles based entirely on hearsay. Daguerreotypes continued to be modeled on copy engravings or drawings, and the process remained characterized as mechanical; it is figured in the *Spectator* article as an engraving made by nature of her own face, so "that we may have copies of it."[11] Daguerreotypes are copies of nature, but all well-made copies are mechanical. The agent in daguerreotypy is nature figured as a mechanically dexterous engraver, and the skill is the production of a mechanically engraved plate.

This explanation seems clearly metaphoric, but the terms are drawn from the practices of picture makers and are not deployed as substitutes for material explanations based on the machinery of the camera and the natural laws of chemistry and optics. This reliance on the vocabulary of pictorial practice is a persistent if not pervasive feature of photographic literature from the moment of invention until well into the 1870s. For example, W.H.F. Talbot dubbed his first invention "Photogenic Drawing," and his second "the Calotype Process of Photogenic Drawing," and figured his camera negatives as copies and his prints as copies of copies, and titled his first book illustrated by photographs *The Pencil of Nature*. Photography continued to be figured as a means of making drawings well into the 1870s, but it was obvious to anyone who reviewed the process that the photographer was not the delineator. Writers on photography (including photographers themselves) produced a charming account of the process in which there was a curious division of labor between the photographer and the sun: the photographer's job was to prepare the sensitive materials (and this could be done well or poorly), but it was sunlight that drew the picture. And it was an easy step to move from this distribution of tasks to the personification of the sun as artist and from this figure to the idea that the sun was both observer and depicter (figure 5.1).

I have been suggesting that the characterization of the daguerreotype as "mechanical" can be seen as an extension of the vocabulary of artistic education and practice, in which manual dexterity, as it related to copying, was portrayed as mechanical and was opposed to the intellectual or imaginative component of visual artistry. The claims, made from 1839 through the late 1850s, about the mechanical character of daguerreotypy and then of photography need to be understood as attempts to assimilate photographic production into the habits of artists and illustrators, regarding the production of pictorial copies (and specifically not in respect to the production of art).

By the late 1850s, the products of photography had lost most of their tinge of the "prodigious" and had come increasingly to be viewed as commodities — the useful products of commerce, technology, and science. This relatively rapid passage from prodigy to something not out of the ordinary is a striking feature of what we now think of as modernity, but equally arresting are the terms in which photographs were transformed from precious fairy-tale marvels into just one among many kinds of things produced for a rapidly expanding popular culture. The change in response to photographs — their exit from the realm of the extraordinary and entry into the world of the everyday — was achieved through the rapid commercialization of photography and the proliferation of photographs throughout Western societies.[12]

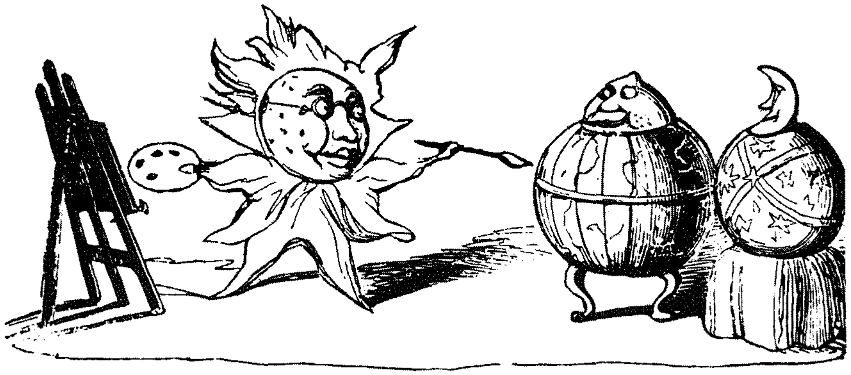

Figure 5.1. Advertisement for the studio of Southworth and Hawes, Boston, 1854.

The discovery in 1840 of means to "accelerate" daguerreotype plates led immediately to daguerreotype portraiture and the establishment of portrait studios for the taking of "likenesses." The demand for cameras, improved lenses, and the various raw material of daguerreotypy led in turn to the formation of networks of manufacturers who produced thousands of items sold centrally through photographic supply houses.[13] By the 1850s, the wet-plate collodion process, a variation of Talbot's calotype process, had overtaken the daguerreotype, and paper prints had come to dominate photographic production. Photographs were assigned comfortable, unremarkable places in the home: on the mantelpiece; behind frames on living room walls; in parlors, where they were kept in family albums; and in wooden boxes that sat beside stereopticons. Photographers' practices were shaped primarily by sales to the aspiring middle and established upper classes, through the production of portraits for clients who were often subjected to steep climbs to the sky-lit top floors of photographic studios and through the manufacture of immense collections of stereographic cards that gave a glimpse of distant cities, exotic worlds, and natural wonders, illustrated the course of empire, and often provided models of bourgeois modes of dress or home furnishings for those who aimed at acceptability in middle-class society. The history of photographic practice began with the annual production of relatively small numbers of daguerreotype plates and paper prints (in the early 1840s), but by the 1850s photography was becoming an industry of large and small studios (some of which flourished while others remained in a perpetual state of near bankruptcy), photographic publishing houses, supply houses, trade journals, and tens of thousands of low-wage photographic-print makers, mostly women and children, on both sides of the Atlantic. The division of labor in large firms was rigid: there were darkroom assistants, camera operators, negative "doctors," print exposers, print processors, and print mounters, in addition to managers, accountants, and the entrepreneur, whose name was embossed under each finished print. In small studios, one or two people handled all these operations. Photography was primarily a picture-making business aimed at maximizing profits and was hardly engaged with issues that preoccupied painters and graphic artists. Whereas some of the first generation had notions of pictorial effect that, when successfully imitated, brought their pictures into conformity with those of skilled artisans in the older graphic media, the following generation was devoted to establishing the differences between photographs and handmade pictures. Starting in the 1850s, photographers adopted means of imparting a high gloss to the surface of their prints (and this gloss increased dazzlingly in the decades that followed) to maximize the articulation of details carried in the negatives and to increase the overall contrast of the pictures, but also to give them the look of mass-produced, machined products. These prints, with their "inhuman finish," were nonetheless made painstakingly and entirely by hand.

Although photographs had achieved remarkable currency by the late 1850s, there seem to have been no attempts to provide positive analyses of the new picture-making medium. Discussions of photography continued to be framed in terms of the comparison to handmade pictures in words drawn from the vocabulary of the pictorial arts. In the spring of 1857, Lady Elizabeth Eastlake, an occasional writer on the subject of art and the wife of Sir Charles Eastlake, president of the Royal Academy, addressed the subject of photography in an essay published in the *Quarterly Review.* "Our chief object at present," she wrote, "is to investigate the connection of photography with art – to decide how far the sun may be considered an artist, and to what branch of imitation his powers are best adapted."[14]

The very success of photography, the exponential increase in the number of photographs produced annually, provoked Eastlake into fashioning an argument directed against the increasing tendency (among the unschooled, or the anesthetic) to confuse photographs with works of art. "[Photography] is made for the present age," she writes, "in which the desire for art resides in a small minority, but the craving, or rather necessity, for cheap, prompt, and correct facts in the public at large."[15] Photography's popularity with the broad public and its appeal as an avocation even to the well educated and well heeled required a blocking maneuver, one that would permit the classification of photographs as pictures while preventing, once and for all, their celebration as works of art.

Eastlake's subtle and complex argument rests on her characterization of visual art as being carefully coordinated with "our experience of Nature."[16] A work of art represents the imaginatively constructed experience of an artist and is addressed to an audience responsive to such depictions. Eastlake assumes that the properties of vision – the ways in which things appear to a sensitive viewer – constitute something like the conditions of visual art. Although photography can, like painting, delineate nature, it cannot produce pictures that accord with "our experience of Nature."

This separation of photography from art requires a doubling of terms: for example, there is truth-to-nature (facts) and truth-to-nature-as-experienced-by-an-artist (art), and the gap between the two is unbridgeable. Photography can produce "cheap, prompt, and correct facts," but photographs cannot be works of art: "Correctness of drawing, truth of detail, and absence of convention, the best characteristics of photography, are qualities of no common kind, but the student who issues from the academy with these in his grasp stands, nevertheless, but on the threshold of art." This is, of course, a restatement of Reynolds's position on the relation of mechanical skills to the production of art. But in this context, it is

more than a simple iteration; it underscores the difficulty of separating claims about the mechanical (machine) character of photographs from those concerning the mechanical qualities of copies in general (whether produced by hand or by machine), and Eastlake herself has difficulty keeping the two separate:

> Far from holding up the mirror to nature, which is an assertion usually as triumphant as it is erroneous, [photography] holds up that which, however beautiful, ingenious, and valuable in powers of reflection, is yet subject to certain distortions and deficiencies for which there is no remedy. The science therefore which has developed the resources of photography, has but more glaringly betrayed its defects. For the more perfect you render an imperfect machine the more must its imperfections come to light: it is superfluous therefore to ask whether Art has been benefited, where Nature, its only source and model, has been but more accurately falsified. If the photograph in its early and imperfect scientific state was more consonant to our feelings for art, it is because, as far as it went, it was more true to our experience of Nature.[17]

The "distortions and deficiencies" Eastlake mentions relate to the harsh contrast of many photographic prints and to a peculiarity of the photographic processes then in use, which were primarily sensitive to blue radiation and, as a consequence, failed to register the equivalent monochrome values of all other colors. One result of this spectral insensitivity is that in order to provide a robust exposure of a green landscape, cloud-filled blue skies must be massively overexposed and appear, therefore, as blank white areas in the finished print.[18] Eastlake might have added that the blond hair of a subject sitting for his photographic portrait fails to have any effect on the plate and appears, consequently, as a black mass in the final print and that red freckles register as black dots. These constitute distortions and defects in Eastlake's view because they are at odds with "our experience of Nature" and with the ways in which painters represent these experiences.

Eastlake locates the distinction between the mechanical and the artistic aspects of painting in the "free-will" of the painter—in the artist's power of selection and rejection, emphasis, deletion, and so on. The distinction is again between copying and interpreting. But photography does not permit interpretation; it demands "obedience to the machine."[19] And so the machinery of photographic production functions as a foil for artistic production. A work of art is "the marriage of [the artist's] mind with the object before him," it is "half stamped with his own features, half with those of Nature," while photography is capable of nothing more than "literal, unreasoning imitation." Because of its dependence on machinery, photography cannot be used to produce art; its value to society is that it is the "sworn witness of everything presented to her view." The realm of photography is the domain of the mechanical, and the virtues of the machine are not human virtues. Machines are incapable of having experiences and so cannot represent them; what they can do is passively copy nature, but these copies, though faithful to nature as it is, are not true to nature as experienced.[20] This double characterization of photography as mechanical—in its apparatus and materials and in the way its products look (they look like copies of their subjects)—is further complicated by Eastlake's understanding of "obedience to the machine." It would be wrong, for instance, to conclude that because photography is mechanical (in the sense of its reliance on machinery), it is therefore predictable, its results automatic or inevitable. One important and overlooked feature of Eastlake's account is her emphasis on the mysterious unreliability of photography. Despite the best efforts of photographers, the processes can fail completely and unaccountably:

> You go out on a beautifully clear day, not a breath stirring, chemicals in order, and lights and shadows in perfection; but something in the air is absent, or present, or indolent, or restless, and you return in the evening only to develop a set of blanks. The next day is cloudy and breezy, your chemicals are neglected, yourself disheartened, hope is gone, and with it the needful care; but here again something in the air is favorable, and in the silence and darkness of your chamber pictures are summoned from the vasty deep which at once obliterate all thought of failure. Happy the photographer who knows what is his enemy, or what is his friend; but in either case it is too often "something," he can't tell what; and all the certainty that the best of experience attains is, that you are dealing with one of those subtle agencies which, though Ariel-like it will serve you bravely, will never be taught implicitly to obey.[21]

Here Eastlake repeats the endless complaints of legions of photographers whose manuals were filled with long sections dealing with unaccountable failures of the process, sections that carried titles like "Manipulation Miseries." Photography seems to have its own Cartesian demon, its own spirit inexplicably toying with the rules of the craft, or abandoning them altogether. Eastlake is faithful to the complaints of photographers and to their capitulation to "those subtle agencies" that often confound explanation and make remedial action impossible. Her invocation of Ariel, Prospero's faithful but willful spirit, is itself confounding: Ariel serves bravely but "will never be taught... to obey." And yet photographers, who are subject to similar willful agencies, are in Eastlake's account thoroughly constrained by "obedience to the machine." It seems that the machinery of photography must be obeyed even though it is often disobedient, subject to chaotic, unknowable forces.

Nonetheless, it might seem that Eastlake's views, to the extent they place emphasis on the machinery of photography, are more or less in compliance with more modern accounts of photography that aim at explaining photographic picture making by reducing it to a series of cause-and-effect operations said to be at the core of photographic production. But while she does invoke "obedience to the machine" to describe what cannot be done with photography, she does not locate depictive agency in the apparatus and materials of the process, or in the relations between them and the things represented in photographs. The machinery does not delineate the picture and neither does the photographer. The pictorial agent in photography is the sun: "Before [the invention of photography] little was the existence of a power, availing itself of the eye of the sun both to discern and to execute, suspected by the world."

The recurrent declarations that the sun, not the photographer or the sensitized materials, is the pictorial agent in the production of photographs can (and often does) strike modern readers as little more than a quaint way of saying the obvious: photographs are produced by the action of light. But the repeated identification of the sun as the depictive power in photography and the steadfast refusal to grant pictorial agency to the photographer suggest that the persistence of (what is often taken to be no more than) a figure of speech is easier to dismiss than to explain. The problem originates in the perfectly justifiable expectation that a picture of any kind must be drawn or sketched. But where is the depictive power to be located in photography? What (or who) draws the picture? As Eastlake describes the process, it is the job of the photographer to produce the photosensitive materials and to allow light into the camera, but it is the task of the sun to *draw* the picture.

Eastlake oscillates between two distinct ideas of the mechanical in order to explain why photographs cannot be works of art,

but she is unable to maintain a clear distinction between a sun-drawn copy and one made by hand. Near the end of the essay, she says:

> For everything which Art, so-called, has hitherto been the means but not the end, photography is the allotted agent — for all that requires *mere manual correctness, and mere manual slavery,* without any employment of the artistic feeling, she is the proper and therefore the perfect medium.[22]

Throughout the first three decades of its practice, photography was thought to be inescapably integumental; capable only of producing copy pictures of the immediately visible, first surfaces of things; it was constrained to deal with the superficial. For all the claims that photographs were mechanical in either sense — as precise, accurate copies of the visible, or as the products of machines — photographers routinely complained about sitters who abhorred their portraits and refused to pay for them, and sitters, for their part, criticized photographers for failing to provide accurate likenesses of them or their families. Police chiefs in New York and London complained about the relative uselessness of pictures in rogues' galleries as aids in the identification of suspected felons; geologists groused about the failure of photographs to mark distinctions between reddish and yellow-brown strata in rock samples photographed in the field; and the staffs of American geological expeditions grumbled about the uselessness of photography for topographical work. The rage photographers felt at times with the perversity of their materials was neatly summed up in the title of an article published in 1865 in a popular American photographic journal: "The Total Depravity and Gymnastics of Inanimate Things Photographic."[23]

Talking Pictures

It is difficult to know whether or not the personification of the sun as the delineator of photographs was intended by writers like Eastlake to be taken seriously as an explanation of photographic representation, but this way of explaining photographic origination raised questions in American courts of law in the 1860s and early 1870s about how photographs could function as legal evidence. During that time, attempts to enter photographs into evidence resulted in challenges to their admissibility by opposing counsel. The possibility of changing the status of, say, a portrait photograph from a picture made for personal use to one that could provide public testimony required reconsidering commonly held opinions about the nature of photographic representation – opinions that were oppositional and fragmentary.

Photographs received sparing use in courts of law in France, Germany, England, and the United States starting in the late 1850s, often for the purpose of identifying claimants as the rightful heirs to estates but also for verifying the authenticity of signatures.

In a famous American case, the *Howland Will* Case (1870), in which the plaintiff (successfully) used photographically copied specimens of a signature as the foundation of his case, the defense attorney demanded to know how a photograph could serve as evidence at all. In his concluding summary statement, he dangled a photograph in front of the jury and exclaimed: "It is nothing but hearsay of the sun."[24] By granting the photograph the power of speech, the lawyer was simultaneously denying its admissibility as evidence: hearsay is inadmissible as evidence in courts of law in the United States.[25] The photograph talked, but, according to the outraged lawyer, its talk did not satisfy the rules of court-sanctioned speech. What it did provide was secondhand testimony, from the point of view of the law, mere chatter – talk about talk, the reliability of which is indeterminate

In what way is a photographic portrait, or a photographic copy of a signature, comparable to gossip? The lawyer's complaint about the photograph of the signature is contingent on the supposition that a photograph repeats what the sun says. This complies with one old legal formulation of hearsay: the photograph is "a statement made out of court by someone who is not the original source [that is, someone who is a nonparty witness], offered for the truth of the matter asserted." The idea, then, is that the sun witnesses a signature and makes an assertion about it (the photograph *is* the statement) *out of court*, and accordingly the statement is necessarily inadmissible. A photograph stands to the facts it asserts in the way a hearsay report stands to the claims of a person who has no place as a witness in a legal action. Everything here turns on the allocation of a witnessing capacity to the sun and on its ability to make assertions. But the sun only makes out-of-court statements, which by the rules governing hearsay cannot be subjected to tests in court. Moreover, the lawyer could allow for the possibility that the photograph in question was thoroughly accurate, just as it is possible that other forms of hearsay might accurately repeat a secondhand report and that *that* report might itself be an accurate account of a matter of alleged fact before the court. The problem is that there is no way to test the reliability of the photographic "statement" because there is no way to cross-examine the photographic picture drawer.

This discussion may seem like a great amount of fuss to make over an innocent figure of speech, but there were real issues here concerning a mismatch between photographic pictures regarded as reports or testimony and the confining, either/or character of a legal system entirely dependent on the distinction between direct evidence and hearsay testimony. But there is another question as well: What was it about the notions of photography then in circulation that ruled out the photographer as the picture maker? Why was it that the sun or nature or, as we will see in a moment, the apparatus and materials of photography — why were they routinely figured as the depictive agents and not the photographer? But for the habit of identifying photographic agency with, say, the sun, photographs could not have been considered hearsay. Sketches or diagrams made by hand could be and often were offered in evidence without objection; cross-examining the picture maker could test their reliability.

The theory of those lawyers who argued against the admissibility of photographs requires the sun to be granted the ability to make intelligible statements (in the form of photographs). But whenever the sun speaks, it does so out of court, and accordingly its assertions are inadmissible as evidence. *Res ipsa loquitur*, yes — but never in court. This is functionally equivalent to ruling that photographs are inherently unreliable.[26]

Unanimity about the legal standing of photographs in American courts was not achieved until the 1880s, and objections to their admission as evidence prior to that decade were hit-and-miss affairs — they were effective in some courts and failed in others. Photography, when addressed in general terms, was, in some way, an unsettling, troubling thing despite its quotidian status. The persistent identification of the sun as the photographic agent and its recurrent personification, its ability to talk, are one index of the difficulty people, even relatively sophisticated lawyers, had with the subject.

Arguments favoring the admissibility of photographs as legal evidence were predicated on the special relations photographs were said to have with the things we see. Prior to the late 1870s, photographs were rarely thought of as capable of revealing "hidden" aspects of things, or of providing evidence of matters invisible to the eye. Photographs submitted as potential evidence in courts of law were understood by those who presented them to

be pictures representing what anyone might have seen when looking at the object or person depicted at the time of the photographic exposure. Studio-made family-album portraits were used, for example, to assist in the identification of persons who claimed to be the long-absent but rightful inheritors of large estates. The belief in a special relation of photographs to the visible world provided the crucial premise for arguments favoring the admission of photographs into evidence.

In 1869, a lawyer practicing in upstate New York, who identified himself with the initials J.A.J., published an essay in which he addressed the issue of the admissibility of photographic evidence, denying that photographs should be treated as hearsay and arguing in favor of admitting them as direct evidence — in fact, as the strongest form of direct evidence. He wrote:

> Is a photograph, considered as a narration or delineation of facts, a piece of hearsay, or of original and direct, evidence. . . ? In identifying a person a witness is produced and required to compare the person presented for identification with him with whom he is sought to be identified, as the latter remains pictured in the witness's mind; that is, with the conception or image of him existing in his "mind's eye." So, if the identification be of one physical object or place with another; the same act of comparison of the thing presented with a mere mental image or idea of it, is required of the witness. . . . The testimony of a witness comparing a person present with the remembered image of a person absent, is, in all its parts, original evidence. Ought we then to rank as secondary evidence either of the three elements of the process of identifying a person by his photograph, which follow, namely, 1. The establishment by proof of the genuineness of the photograph; 2. The statement or narration of facts made, if I may so say, *by the picture itself*; and, 3. The comparison, by witnesses, or by a jury directly, of the person offering himself, with that picture. . . .

> At first view, doubtless, a photograph seems a mere piece of hearsay evidence. It is what the witness vouching for its genuineness says, the photographic apparatus, acting in conjunction with sunlight and chemical reagents at the time of taking it, affirmed to be an accurate likeness of the person who sat for it. It differs from hearsay, however, in one essential particular; it is wholly free from the infirmity which causes the rejection of hearsay evidence, namely, the uncertainty whether or not it is an exact repetition of what was said by him whose testimony is repeated by the witness. In the picture we have before us, at the trial, precisely what the apparatus did say. Its language is repeated to us, syllable for syllable. . . .
>
> If I am correct in this, a photograph proved to be that of a person absent is that person himself, precisely as he exists in that article of vision – is, therefore, direct and original evidence of the kind of man he was. So, of the photographic likeness of any natural object or place. When shown to be the photograph of the place or object, it is original – that is, legally speaking, the best – evidence of its features and relations; as much so as the testimony of a witness speaking from memory of the same features and relations.[27]

J.A.J.'s argument begins with a psychological account of the way in which a witness routinely identifies people. The idea here is that every act of visual identification requires the comparison of what we see with a recalled mental image; recognition is based on matching what we see against a remembered image. J.A.J. then turns to the issue of the veracity of photographs and argues that the agents in photography – sunlight, chemical reagents, and the photographic apparatus (the photographer still remains out of the picture, as it were) – speak and speak truthfully. This formulation is then condensed: "In the picture we have before us, at the trial, precisely what the apparatus did say. Its language is repeated to us, syllable for syllable." And suddenly we have a chorus of things that

talk – light, chemicals, cameras, and the photograph itself – all of which do so, presumably, in unison and, perhaps, in harmony.

The final move in J.A.J.'s argument is to insist on the special relation of photograph to vision: "[A] photograph proved to be that of a person absent is that person himself, *precisely as he exists in the article of vision*." Photographs can talk in court because they not only tell the truth but tell it better than eyewitnesses, who must rely on evanescent mental images in order to make identifications. J.A.J. does not explicitly invoke the camera-eye analogy, but his identification of the photographic portrait with the subject as he is seen recalls the old claims about photographs as mechanical copies of nature carefully observed. He may, in fact, be invoking the camera-eye analogy because it was very much in the air at the time, thanks to the speculation of Heinrich Kuehne in 1868 that the last thing seen by a person at the moment of death is impressed photographically on the retina and might be retrieved via chemical means.[28]

A judge of the Texas Appellate Court in an 1877 ruling relied explicitly on the camera-eye analogy in his opinion favoring the admissibility of photographs into evidence by arguing that all witnesses at all times have necessarily based their testimony on photographs:

> Every object seen with the natural eye is only seen because photographed on the retina. In life the impression is transitory; it is only when death is at hand that it remains permanently fixed on the retina. Thus we are secure in asserting that no witness ever swore to a thing seen by him, without swearing from a photograph. What we call sight is but the impression made on the mind through the retina of the eye, which is nature's camera.[29]

According to the judge, the photographic character of vision itself justifies, as nothing else could, the introduction of photographs into evidence. He effectively converts photographs into eyewitness testimony (the relation is symmetrical: eyewitness testimony is based on photographs). This alignment of photography with vision was possible only as long as photographs could plausibly be construed as limited to the realm of the visible. With the advent of highly photosensitive emulsions and instantaneous exposures (which were soon brought to the attention of the public), it would no longer be possible to view photography as corroborating vision, as limited solely to the realm of the visible.

It might seem that an understanding of vision as being of the nature of a photograph would bring an end to all the talk about talking things — sun, apparatus, chemicals, photographs — and in a way it did. But it did not put an end to the linguistic character of photographs. The appellate judge continues:

> Science has discovered that a perfect photograph of an object, reflected in the eye of one dying, remains fixed on the retina after death. (See recent experiments stated by Dr. Vogel in the May number, 1877 of *Philadelphia Photographic Journal* [*sic*: the *Philadelphia Photographer*].) Take the case of a murder committed on the highway: on the eye of the victim is fixed the perfect likeness of a human face. Would this court exclude the knowledge of that fact from the jury on the trial of the man against whom the glazed eye of the murdered man thus bore testimony? In other words, would a living eyewitness, whose memory only preserved the fleeting photograph of the deed, be heard, and the permanent photograph on the dead man's eye be excluded? We submit that the eye of the dead man would furnish the best evidence that the accused was there when the deed was committed, for it would bear a fact, needing no effect of memory to preserve it. It would not be parol evidence [akin to hearsay] based on uncertain memory, but the handwriting of nature, preserved by nature's camera.[30]

The judge relieved photographs of the capacity to speak, but their value as legal testimony continued to be contingent on their ability to communicate by way of language. Photographs lost their voice but achieved the status of truthful texts. And so photographs were transformed into legal documents by achieving the status of writing.

(1890), *Scientific Papers*, vol. 3, p. 382; Rayleigh, *John William Strutt*, pp. 182–83; Lord Rayleigh [John Strutt], "On the Tension of Water Surfaces" (1890) and "On the Theory of Surface Forces" (1890), in *Scientific Papers*, vol. 3, pp. 383–425; Lord Rayleigh [John Strutt], "Experiments upon Surface Films" (1892), *Scientific Papers*, vol. 3, p. 569.

37. Lord Rayleigh [John Strutt], "Some Applications of Photography" (1891), in *Scientific Papers*, vol. 3, pp. 446–48.

38. "The Velocities of Projectiles," *Nature* 42 (1890), pp. 250–51; Charles Vernon Boys, "On Electric Spark Photographs," *Nature* 47 (1893), pp. 415–21 and 440–46; Charles Vernon Boys, "On the Photography of Flying Bullets by the Light of the Electric Spark," *Journal of the Royal United Services Institution* 37 (1893), pp. 855–73. For Mach and Boys, see Peter Geimer, "Ein Projektil und sein Selbstporträt," in Christoph Hoffmann and Peter Berz (eds.), *Über Schall: Ernst Machs und Peter Salchers Geschossfotografien* (Göttingen: Wallstein, 2001), pp. 347–50. For Boys's Edinburgh show, see C.G. Knott, *Life and Scientific Work of Peter Guthrie Tait* (Cambridge, UK: Cambridge University Press, 1911), p. 34.

39. Frederick Talbot, *Moving Pictures: How They Are Made and Worked* (London: Heinemann, 1912), p. 39; John Barnes, *The Beginnings of Cinema in England, 1894–1896*, rev. ed. (Exeter: University of Exeter Press, 1998), pp. 8, 15–17, 38–41, 46; Mannoni, *Great Art of Light and Shadow*, pp. 434–35. For Boys's use of the animatograph, see Boys to Stokes, Dec. 23, 1897, and Stokes to Boys, Dec. 25, 1897, in Larmor, *Memoir and Correspondence of Stokes*, vol. 2, pp. 353–54.

40. Arthur Worthington, *A Study of Splashes*, ed. Keith Irwin (New York: Macmillan, 1963), pp. ix–xviii; Arthur Worthington, "On the Surface Forces in Fluids," *Philosophical Magazine* 18 (1884), pp. 334–64; Arthur Worthington, "On the Stretching of Liquids," *British Association Reports* (1888), pp. 583–84; Worthington to Stokes, March 22, 1881, June 7, 1881, April 29, 1882, May 7, 1882, and Stokes to Worthington, May 18, 1882, in Stokes MSS, University Library Cambridge, MSS Add 7656 W1089–93; Arthur Worthington, "The Splash of a Drop and Allied Phenomena," *Proceedings of the Royal Institution* 14 (1894), pp. 300 and 302.

41. Worthington, "Splash of a Drop," p. 289; Worthington, *Study of Splashes*, pp. 2 and 118–20. For *Pearson's Magazine*, see Peter Broks, *Media Science Before the Great War* (London: Macmillan, 1996), pp. 18–19 and 108. For Thomson's new work on foam shapes, see "On the Molecular Tactics of a Crystal" (1893), in Thomson, *Baltimore Lectures*, pp. 602–42.

42. Henri Béhar, *Les Cultures de Jarry* (Paris: PUF, 1988), pp. 193–99; Keith

Beaumont, *Alfred Jarry: A Critical and Biographical Study* (Leicester: Leicester University Press, 1984), pp. 179–203; Alfred Jarry, *Gestes et opinions du docteur Faustroll, pataphysicien*, ed. Noel Arnaud and Henri Bordillon (Paris: Gallimard, 1980), pp. 184–85 and 216–18. Citations from Jarry are from *Adventures in 'Pataphysics*, ed. Alastair Brotchie and Paul Edwards (London: Atlas, 2001), p. 36, and *Exploits and Opinions of Doctor Faustroll, Pataphysician*, ed. Simon Watson Taylor (Boston: Exact Change, 1996), pp. 14–17.

43. Béhar, *Cultures de Jarry*, pp. 195–99; Jarry, *Doctor Faustroll, Pataphysician*, pp. 100–6. For Grandville, see Walter Benjamin, *Paris, capitale du XIXe siécle*, 2nd ed. (Paris: Cerf, 1993), pp. 40 and 850; Stanley Appelbaum, ed., *Fantastic Illustrations of Grandville* (New York: Dover, 1974), p. 49. For Guillemin, see Bruno Béguet, ed., *La Science pour tous: Sur la vulgarisation scientifique en France de 1850 à 1914* (Paris: CNAM, 1990), pp. 44 and 164.

44. For inventory investment and the early museum, see Harold Cook, "Time's Bodies: Crafting the Preparation and Preservation of Naturalia," in Pamela Smith and Paula Findlen (eds.), *Merchants and Marvels: Commerce, Science, and Art in Early Modern Europe* (London: Routledge, 2002), pp. 223–47. Boys's remark from *Soap Bubbles* (1890), p. 134, is omitted from later editions.

Chapter Five: *Res Ipsa Loquitur*

1. "Self-Operating Processes of Fine Art: The Daguerreotype," *Spectator* 12, no. 553 (Feb. 2, 1839) p. 17. The author of the article notes: "We have not seen one impression of these light-created monochromes."

2. It is, he says, a "chemical process of picturing and engraving," one among a small number of "other [recently invented] self-acting machines of mechanical operation." *Ibid.*, p. 18.

3. *Ibid.*

4. "Some who have never raised their minds to the consideration of the real dignity of the art, and who rate the works of an artist in proportion as they excel, or are defective in the mechanical parts, look on theory as something that may enable them to talk but not to paint better, and confining themselves entirely to mechanical practice, very assiduously toil on in the drudgery of copying, and think they make a rapid progress while they faithfully exhibit the minutest part of a favorite picture." Sir Joshua Reynolds, *Discourses on Art* (New Haven, CT: Yale University Press, 1959), discourse 2, p. 29.

5. *Ibid.*, discourse 1, p. 17. Reynolds immediately follows with: "This seems to me to be one of the most dangerous sources of corruption; and I speak of it

from experience, not as an error which may possibly happen, but which has actually infected all foreign Academies."

6. *Ibid.*, discourse 7, p. 117.

7. "He who endeavors to copy nicely the figure before him not only acquires a habit of exactness and precision, but is continually advancing in his knowledge of the human figure." *Ibid.*, discourse 1, pp. 20–21.

8. Some colleagues who have commented on this paper have suggested that the non-machine sense of "mechanical" is parasitic on the machine sense. My highly informal research suggests otherwise. The oldest sense (1432–1450) for the word as given in the *Oxford English Dictionary* is "1. Of arts, trades, occupations: Concerned with machines or tools. Hence, a. Concerned with the contrivance and construction of machines or mechanism." But the next listed sense of "mechanical" (1450) is: "b. Concerned with manual operations; of the nature of handicraft."

9. What examples of natural accuracy could the author have in mind? Does he imagine, for example, that sexual reproduction is a form of copying?

10. "Self-Operating Processes of Fine Art," p. 18.

11. Although the daguerreotype permits nature to produce engravings of *her* face, the author of another precocious review of the daguerreotype, published in April 1839, writes: "M. Daguerre has not succeeded in copying the living physiognomy in a satisfactory manner, though he does not despair of success." "New Discovery in the Fine Arts: The Daguerreotype," *New Yorker*, April 20, 1839, p. 31.

12. "[P]hotography has become a household word and a household want; is used alike by art and science, by love, business, and justice; is found in the most sumptuous saloon, and in the dingiest attic – in the solitude of the Highland cottage, and in the glare of the London gin-palace – in the pocket of the detective, in the cell of the convict, in the folio of the painter and architect, among the papers and patterns of the mill owner and manufacturer, and on the cold brave breast on the battle-field." Lady Elizabeth Eastlake, "Photography," *Quarterly Review* (London), 1, no. 101 (April 1857), reprinted in Beaumont Newhall (ed.), *Photography: Essays and Images* (New York: Museum of Modern Art, 1980), p. 81. All page citations to this essay refer to the Newhall volume.

13. The "improvements" to lenses related to their increased resolving power (for making more detailed copies) and to their ability to produce brighter images (and thus quicker exposures).

14. Eastlake, "Photography," p. 84.

15. *Ibid.*, p. 93.

16. The extension of "our" here is obviously restricted to the "small minority" who desires art.

17. Eastlake, "Photography," p. 91.

18. The green of the foliage reflects a small proportion of the blue radiation falling on it. In order for the foliage to register on the plate, it is necessary to prolong the exposure, but areas of the scene that are rich in blue radiation are overexposed in the process of waiting for the green areas to register.

19. "The power of selection and rejection, the living application of that language which lies dead in his paint-box, the marriage of his own mind with the object before him, and the offspring, half stamped with his own features, half with those of Nature, which is born of the union – whatever appertains to the free-will of the intelligent being, as opposed to the obedience of the machine – this, and much more than this, constitutes that mystery called Art, in the elucidation of which photography can give valuable help, simply by showing what it is not." Eastlake, "Photography," p. 94.

20. Handmade copies are likewise "literal, unreasoning imitations."

21. Eastlake, "Photography," p. 89.

22. *Ibid.*, p. 93. Emphasis added.

23. *Philadelphia Photographer* 2, no. 22 (Oct. 1865), pp. 155–57.

24. "The Howland Will Case," *American Legal Review* 4, no. 625 (July 1870), pp. 644–53.

25. A recent textbook of legal evidence, which repeats the century-and-a-half-old formulation of "hearsay," defines it as follows:

> *Hearsay testimony* is secondhand evidence, it is not what the witness knows personally, but what someone else told him or her. Gossip is an example of hearsay. In general, hearsay may not be admitted in evidence, but there are exceptions. For instance, if the accused is charged with uttering certain words, a witness is permitted to testify that he or she heard the accused speak them.
>
> The following examples illustrate hearsay that is inadmissible:
>
> 1. SN Water, the accused, is being tried for desertion. BMC Boate cannot testify that BM3 Christmas told him that SN Water said he (Water) intended to desert.
>
> 2. The accused is being tried for larceny of clothes from a locker. A testifies that B told him that she saw the accused leave the space where the locker was located with a bundle of clothes about the same time the

> clothes were stolen. This testimony from A would not be admissible to prove the facts stated by B.
>
> Neither BMC Boate nor A would be allowed to testify, but the trial counsel could call BM3 Christmas and B as witnesses. The fact that hearsay evidence was given to an officer in the course of an official investigation does not make it admissible.

26. It may be that now current attitudes toward polygraph tests parallel the attitudes toward photography that held them to be hearsay evidence.

27. J.A.J., "The Legal Relations of Photographs," *American Law Register* (Albany, New York), 1, no. 1 (Jan., 1869), pp. 59–60.

28. "The Legal Relations of Photography," *Albany Law Journal* 5 (Jan. 25, 1873). "It has been asserted that the last objects which a dying man sees remain sufficiently long upon the retina of the eye to admit of being enlarged and preserved by photography. If this be true, in the case of a murdered man, the surrounding objects and persons in their actual attitudes may be ascertained. Although we have no case in which this scientific fact has been utilized in the identification of a murderer, such a use is by no means improbable in the future."

29. *William Eborn* v. *George B. Zimpelman, Adm'r &c.*, 47 Texas 503 (1877).

30. *Ibid.*

Chapter Six: The Glass Flowers

My hearty thanks to Susan Rossi-Wilcox of the Harvard Museum of Natural History, Don Pfister of the Harvard University Herbaria, Chris Meechan of the National Museum and Gallery at Cardiff, Henri Reiling of Utrecht University, James Peto of the Design Museum in London, and the staff of the Harvard University Archives for their generosity in making materials concerning the Blaschka models available to me and for their knowledgeable counsel. I am also grateful to Debora Coen for research assistance in the Harvard archives, to Rupal Pinto for allowing me to read her senior thesis, to Denise Phillips for advice concerning Dresden scientific societies, and to Martha Fleming for information about the artistic uses to which the Blaschka models have recently been put.

1. Goodale had begun negotiations with the Blaschkas soon after the Department of Botany was granted permission to construct the central portion of the Harvard University Museum in 1885. The story of his first visit to the Dresden workshop was subsequently told and retold: see [George Lincoln Goodale], *The Ware Collection of Blaschka Glass-Models of Plants in Flower* (Cambridge, MA: n.p., 1915), Harvard University Archives, HUF 231.115.34; and *Harvard University Annual Reports of the President and the Treasurer, 1890–91*, pp. 160–61.

2. The Ware family connection with Harvard College went back generations; Henry Ware had been president in 1828–1829. Rupal Pinto, "Making Harvard's Glass Flowers: The Interface of Botany, Gender, and Artistic Virtuosity in America" (senior honors thesis, Department of the History of Science, Harvard University, 2002), pp. 69–70.

3. Accounts of her visits may be found in "How Were the Glass Flowers Made? A Letter by Mary Lee Ware," *Botanical Museum Leaflets* 19 (1961), pp. 125–36 (the letter in question, dated Oct. 3, 1928, is addressed to Professor Oakes Ames); earlier visits in the company of Goodale are recorded in the diaries (1901) of Henrietta Jewell Goodale, Schlesinger Library, Radcliffe College, 2001-M34.

4. They are arranged according to the Engler-Gilg system of plant classification. See Richard Evans Schultes and William A. Davis, *The Glass Flowers at Harvard*, photographs by Hillel Burger (1982; Cambridge, MA: Botanical Museum of Harvard University, 1992), p. 10; Adolf Engler, *Die natürlichen Pflanzenfamilien nebst ihren Gattungen und wichtigeren Arten insbesondere der Nutzpflanzen* (Leipzig: Engelmann, 1887).

5. Pliny the Elder, *Historia naturalis*, 35.36.65; on the *fortuna* of this story, see Ernst Kris and Otto Kurz, *Legend, Myth, and Magic in the Image of the Artist*, trans. Alastair Laing and Lottie M. Newman (1934; New Haven, CT: Yale University Press, 1979), pp. 62–64. On metal casts and Palissy ware, see Ernst Kris, "'Der Stil Rustique': Die Verwendung des Naturabgusses bei Wenzel Jamnitzer und Bernard Palissy," *Jahrbuch der Kunsthistorischen Sammlung*, new ser., 1 (1926), pp. 137–208. On automata, see Musée National des Techniques, *Jacques Vaucanson* (Ivry: Salles et Grange, 1986); and Horst Bredekamp, *Antikensehnsucht und Maschinenglauben: Die Geschichte der Kunstkammer und die Zukunft der Kunstgeschichte* (Berlin: Klaus Wagenbach, 1993).

6. On the fascination with facsimiles, see Hillel Schwartz, T*he Culture of the Copy: Striking Likenesses, Unreasonable Facsimiles* (New York: Zone Books, 1996), esp. pp. 351–54 concerning artificial flowers.

7. Mary B. Hesse, *Models and Analogies in Science* (London: Sheed and Ward, 1963); Mary Morgan and Margaret Morrison, eds., *Models as Mediators: Perspectives on Natural and Social Sciences* (Cambridge, UK: Cambridge University Press, 1999); Soraya de Chadarevian and Nick Hopwood, eds., *Models: The Third Dimension of Science* (Standord, CA: Stanford University Press, forthcoming).

8. On embryos, see Nick Hopwood, *Embryos in Wax: Models from the Ziegler*